Climate Change

What to think and what to do

3. Evidence, Tipping Points, New Tech and Projections

We don’t inherit the Earth from our ancestors, we borrow it from our children.

Evidence, Tipping Points, New Tech and Projections

- Evidence – what we know (and *who's NOT going to save us*)
- Feedback/Tipping Points – how things might get completely out of hand
- New tech – how we might rein things in
- Projections – where we're currently headed

Evidence – from the IPCC

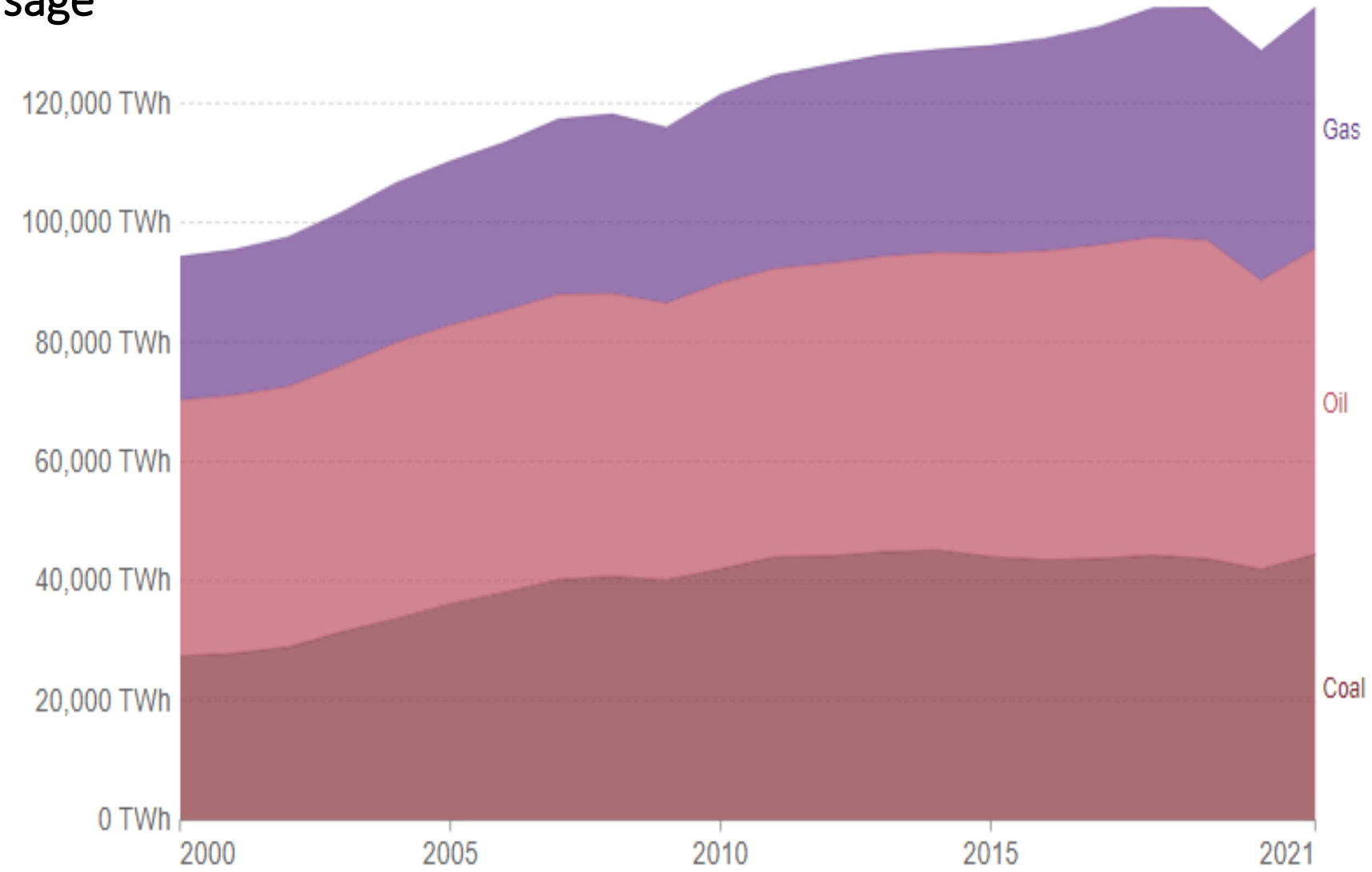
The IPCC presents six main lines of evidence for climate change:

1. It has tracked the *unprecedented* recent rise in atmospheric CO_2 and other GHGs since the beginning of the industrial revolution.
   - Since then, CO2 is up from 280 ppm to 387 ppm (40%) - highest for two million years.
   - Methane up from 715 ppb in 1750 to 1,774 ppm in 2005 - highest for at least 650,000 years.
2. It knows from laboratory and atmospheric measurements that GHGs do indeed absorb heat when they are present in the atmosphere.
3. It has tracked significant increase in global temperatures of 0.85°C and sea level rise of 20cm over the past century.
4. It has analysed the effects of natural events such as *sunspots and volcanic eruptions* on the climate, and though these are essential to understand the pattern of temperature changes over the past 150 years, they *cannot explain* the overall warming trend.
5. It has observed significant changes in the Earth's climate system including
   - reduced snowfall in the Northern Hemisphere
   - retreat of sea ice in the Arctic
   - retreating glaciers on all continents
   - shrinking of the area covered by permafrost and the increasing depth of its active layer.
   - All of which are consistent with a warming global climate.
6. It continually tracks global weather and has seen significant shifts in weather patterns and an increase in extreme events.
   - Patterns of precipitation (rainfall and snowfall) have changed, with parts of North and South America, Europe and northern and central Asia becoming wetter, while the Sahel region of central Africa, southern Africa, the Mediterranean and southern Asia have become drier.
   - Intense rainfall has become more frequent, along with major flooding.
   - They're also seeing more heat waves. According to the US National Oceanic and Atmospheric Administration (NOAA) between 1880 and the beginning of 2014, the 13 warmest years on record have all occurred within the past 16 years.

Latest reports are soon out of date, and things get clearer and worse

Evidence – Fossil Fuel usage

- Despite everything, still we guzzle, more every year…



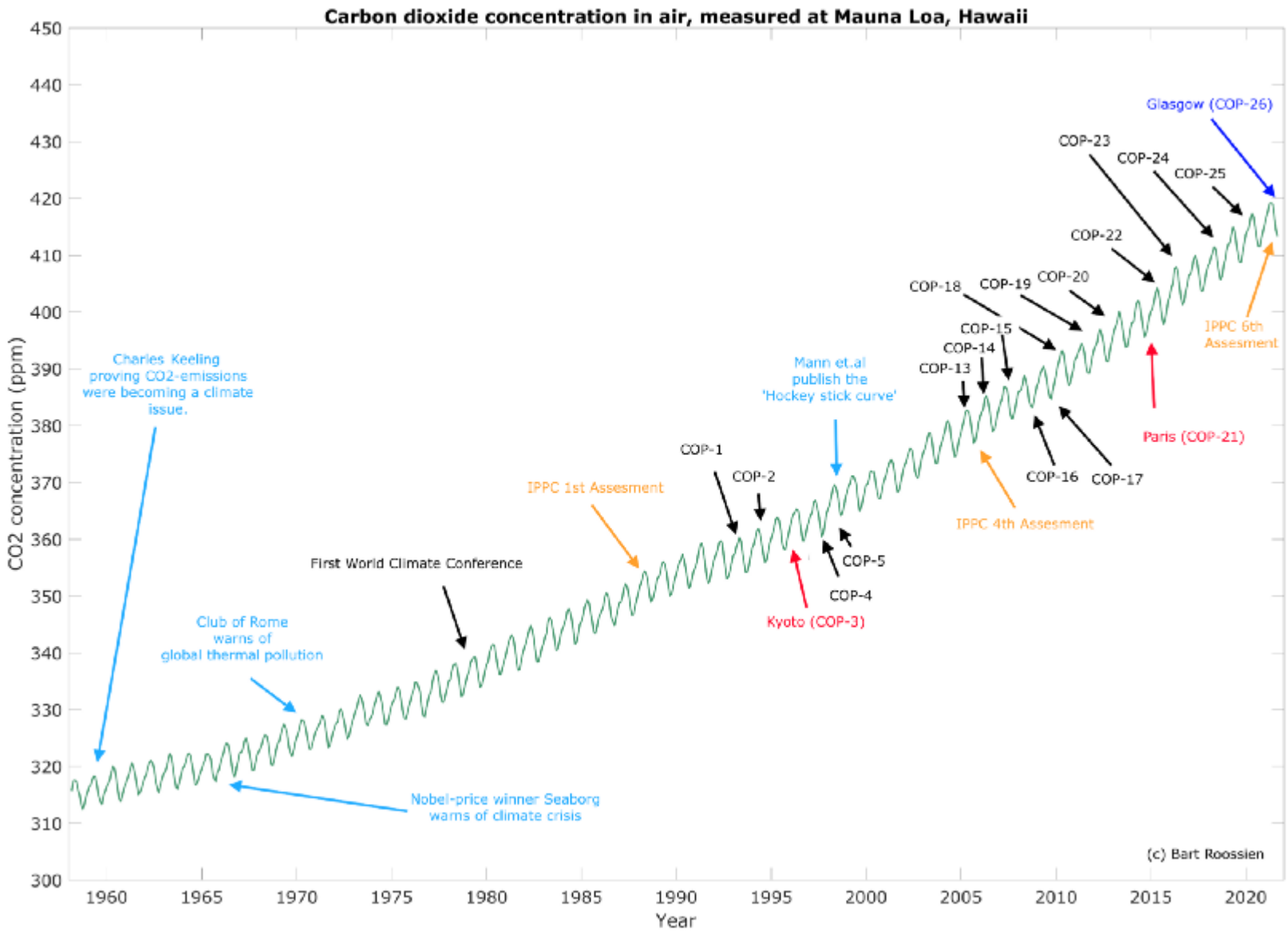
Global primary energy consumption by fossil fuel source (TWh).
OurWorldInData.org/fossil-fuels - Vaclav Smil (2017) and BP Statistical Review of World Energy

Evidence – Global CO_2

Carbon dioxide levels in the air over the past 60 years - with notable scientific warnings and political meetings.
Data source: NOAA

So basically, nothing we have done has made any difference (yet)

Which tells us…..



Evidence – we can't rely on COPs

COPs

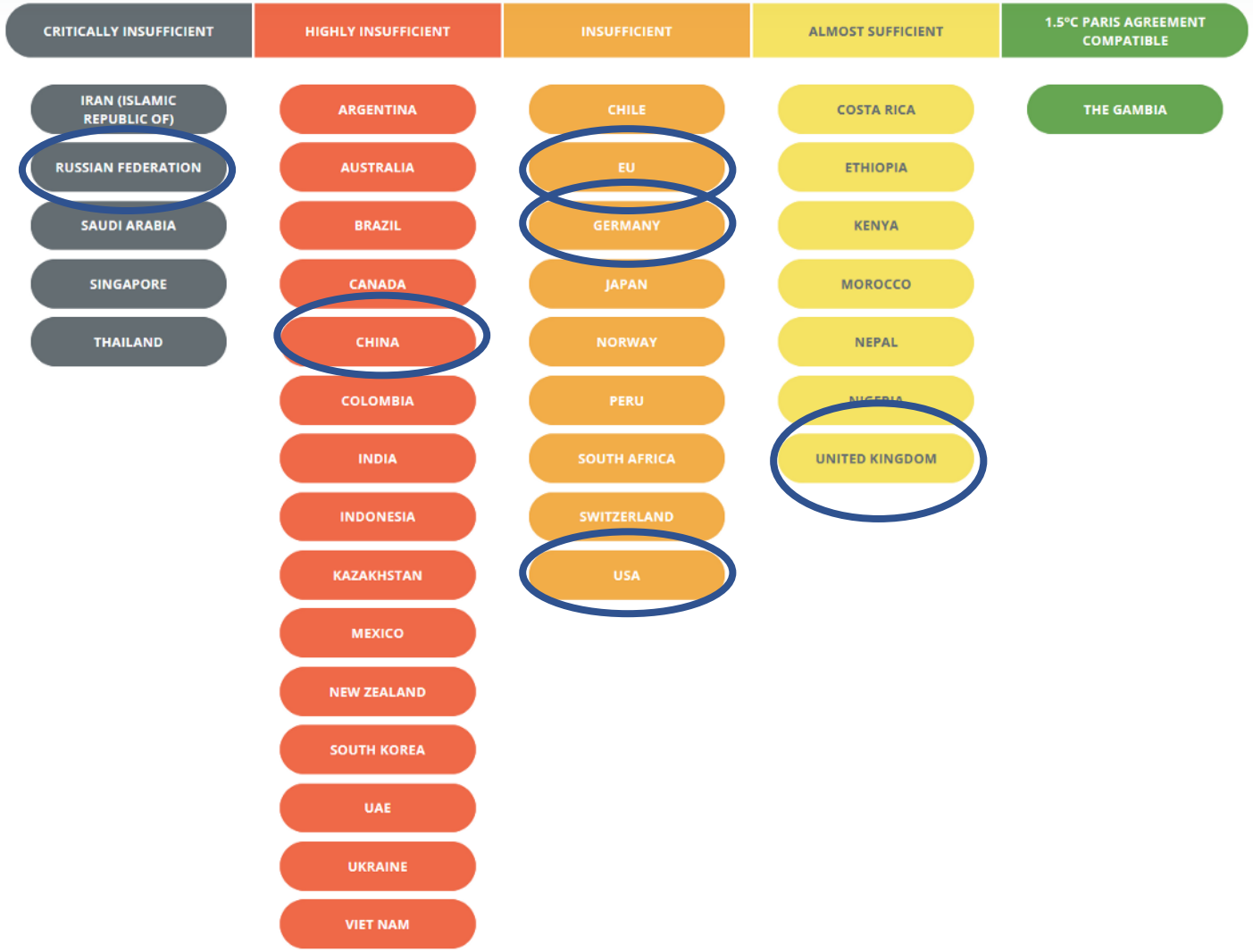
- are supposed to use the IPCC data to agree a way forward, but
- in practice are so complex and so politically infiltrated by FF producers (both countries, corporates and lobbyists) that they achieve very little other than to raise awareness.
- The ultimate guide to why the COP26 summit ended in failure and disappointment (despite a few bright spots) (theconversation.com)
  - Even if all COP26 pledges are met, the planet is on track to warm by 2.1 degC
  - India is the world's third-largest emitter of GHG, & relies heavily on coal
    - coal-powered generation is expected to grow by 4.6% each year to 2024. India was the most prominent objector to the "phase out" wording, but also had support from China.
  - The UK is hell bent on opening a new coal mine, Germany is expanding one.
- Why the Next Climate Conference in Glasgow (COP-26) Won't Make Any Difference | by Bart Roossien | Climate Conscious | Medium
- The Egypt COP also largely failed, and we can't expect the UAE COP to change this trend. (UAE??!!)

Evidence – we can't rely on Governments

Current climate action plans by country

Source:
[Climate Action Tracker]

Basically, nowhere near the mark



Evidence – we can't rely on International Agencies 1

They're shouting, but no-one is listening

The United Nations

- Essentially toothless
- Emissions Gap Report 2022 (unep.org) (UN Environment Programme)
  - Progress "*woefully inadequate*". There is "*no credible pathway to 1.5 degC*"
  - *".. in cold scientific terms, we have to stop filling our atmosphere with greenhouse gases, and stop doing it fast.*
  - *"We had our chance to make incremental changes, but that time is over.*
  - *Only a root-and-branch transformation of our economies and societies can save us from accelerating climate disaster.*
  - *"[We must] almost halve greenhouse gas emissions by 2030. Every fraction of a degree matters: to vulnerable communities, to ecosystems, and to every one of us."*

Inger Andersen, the executive director UNEP

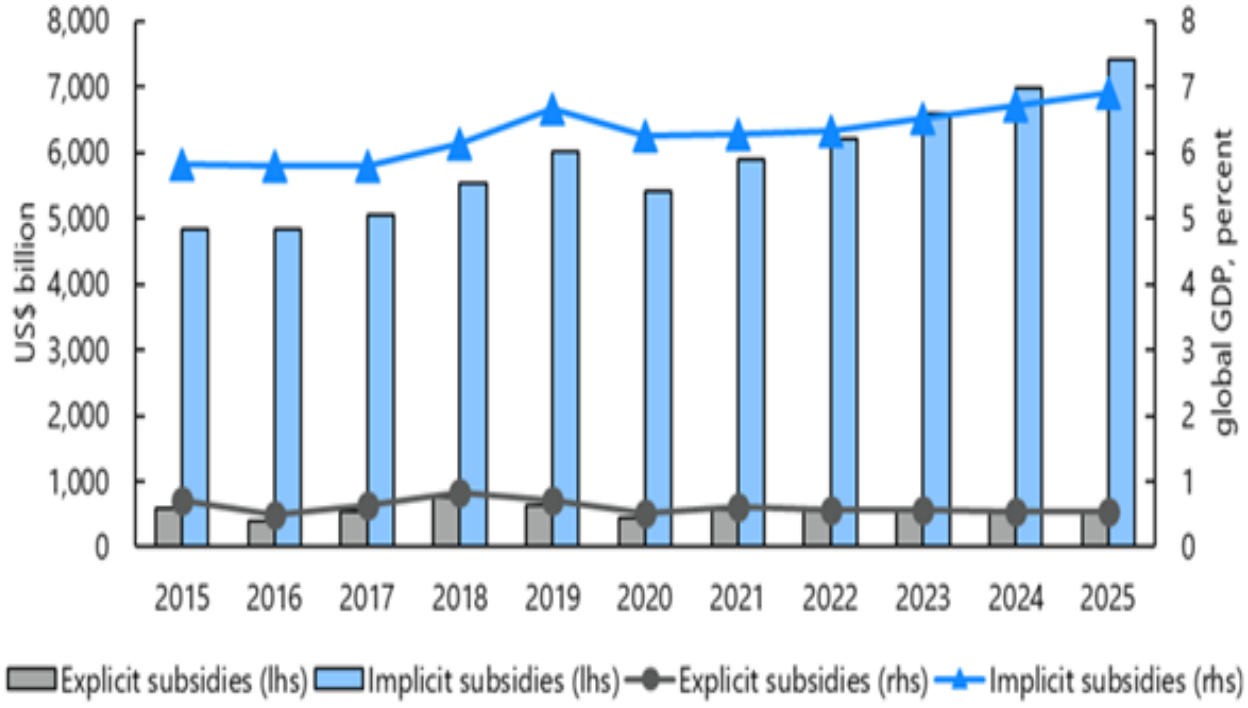
The IEA (International Energy Authority, not the right wing think tank)

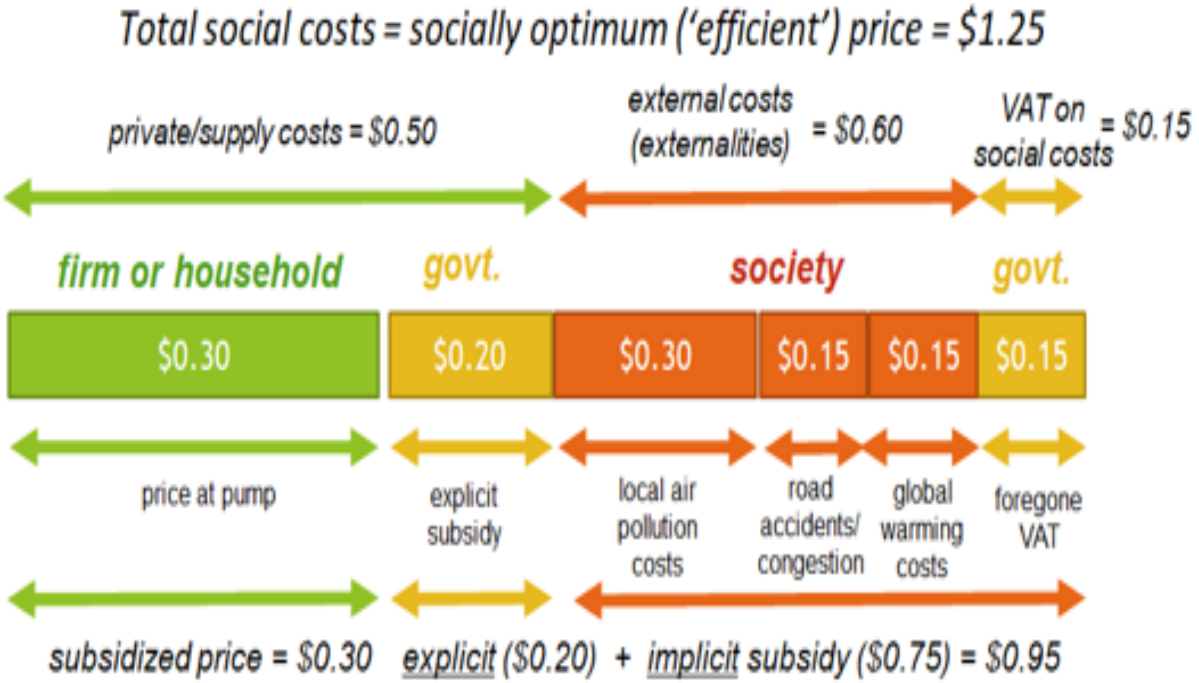
- There is progress:
  - CO_2 from FF usage will peak in 2025 (the Ukraine war and Covid inflation have helped), ie. keep rising until then
  - Clean energy Investment will grow 50% by 2030, reaching $2tn/yr
- BUT:
  - This is half the $4tn/yr level needed by 2030, to reach net zero by 2050, and
  - IEA's own analysis matches UNEP – we're headed for 2.5 degC on current policies

Evidence – we can't rely on International Agencies 2

The IMF

- Still can't think outside its box (Free Market Capitalism or FMC)
- But within that framework, has begun to do some good:
  - Report on Fossil Fuel Subsidies (imf.org) – *"removing subsidies (of ~$6 trillion annually, yes that's $11 million per minute, and rising) would reduce CO_2 emissions in 2025 by 36%"*





A climate expert's view on the parlous state of public action

Professor Kevin Anderson – for recording of his presentation earlier this year in Cambridge
From iniquity to integrity … there's no hiding from carbon budgets (climateseries.com)
Or search for:
Cambridge Climate Lecture Series
#CCLS2023 A Forum For Discussing Climate Change - Cambridge, UK

As climate change increasingly exacerbates extreme weather events around the globe, so government leaders are increasingly using the language of a "climate emergency". But look beyond the fine words, and it is quickly evident that behind the relatively recent framing of 'net zero', many governments, companies and institutions are planning for little more than incremental adjustments to business-as-usual.

But "nature will not be fooled" by empty rhetoric, subterfuge and unsubstantiated optimism – and nor should we. The challenges we face in delivering on our Paris climate commitments beg fundamental questions of almost every facet of modern society. This presentation will seek to lay bare the sheer scale, scope and urgency of emission cuts now required to meet our Paris climate commitments. It will conclude by offering an outline of the key characteristics delivering on such commitments needs to entail.

Please note, for those with a more sensitive disposition, this is very much a "red pill" presentation.

Much more eminent than me (100x) – but looks like I'm on the same page as him!

TL;DR: "*I see no route out of this without revolution. The trouble is that by our inaction, we are choosing to make that revolution a violent one.*"

Tipping Points – Feedback Loops

- A *feedback loop* occurs where the output positively or negatively affects the input, so leading either to:
  - Self-regulating systems (like a pendulum swinging back to the mid-point)
  - Systems that run out of control (like a fire spreading from a match-head)
- They occur all over the climate system, and interact – e.g. a slow river cuts more into the outer bank than the inner, but eventually, an Ox-Bow lake is formed.
- On the whole, *in aggregate*, the system self-regulates
  - E.g. more heat → more cloud → more reflection → cooling back
  - ….until recently.

Tipping Points – Examples of Feedback Loops

Examples in the climate

- *Albedo in the Arctic*
  - Rising temperatures are melting arctic sea ice
  - Exposing more dark water to sunlight.
  - Open water absorbs far more of the sun's energy than ice, which reflects much of it
  - leading to further warming. This results in more melting sea ice.
- *Permafrost methane*
  - Methane and carbon can be found in Arctic permafrost, as well as in frozen peat bogs and under sediment on the sea floor.
  - As these bogs and permafrost thaw thanks to climate change, some of the methane and carbon within is released into the atmosphere,
  - adding yet more GHGs that can lead to further global warming.
  - More warming results in more permafrost loss, and so on.

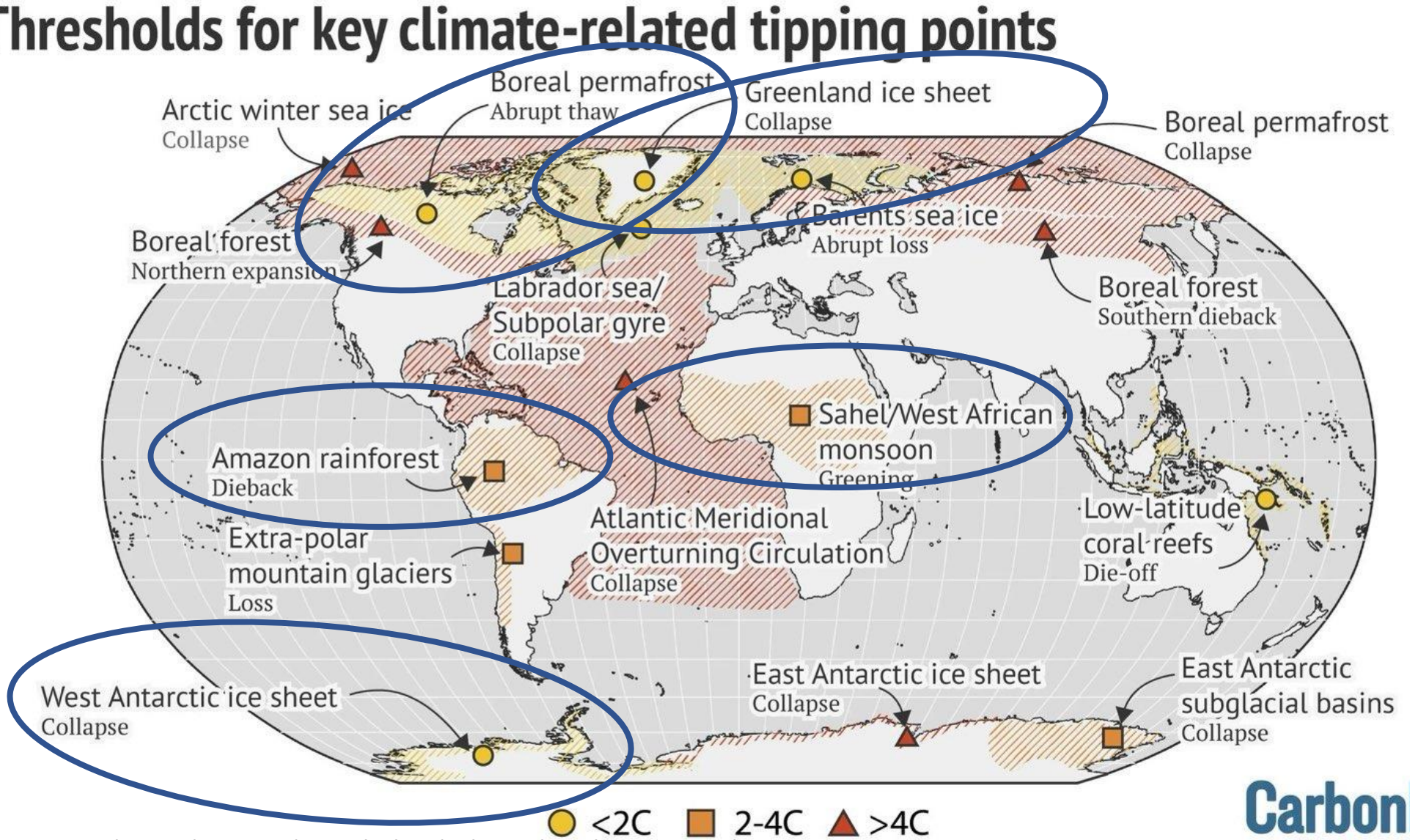
Tipping Points, and Examples of Tipping Points

- A *tipping point* is "*a critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly*."
  - When nudged, a glass settles back onto its base – until nudged hard enough to take it past its tipping point. The glass topples.
  - Not all tipping points lead to abrupt or irreversible change – but many do.
  - The abrupt and irreversible ones are likely to cause the most harm.
- Examples:

  The Greenland ice sheet
  - may reach a point where it is committed to continue shrinking away. It won't be abrupt (200 yrs?) but it will be irreversible, and
    - will raise sea levels globally – perhaps 1m every 50 years
    - (less well known) will acidify oceans, massively disrupting food chains (and the Gulf Stream?)

  The Amazon rainforest
  - may shrink by 80% due to longer dry seasons and more droughts. This will be quick (30 years?), hard to reverse, and devastating locally with impacts felt far away.

Globally Identified Tipping Points

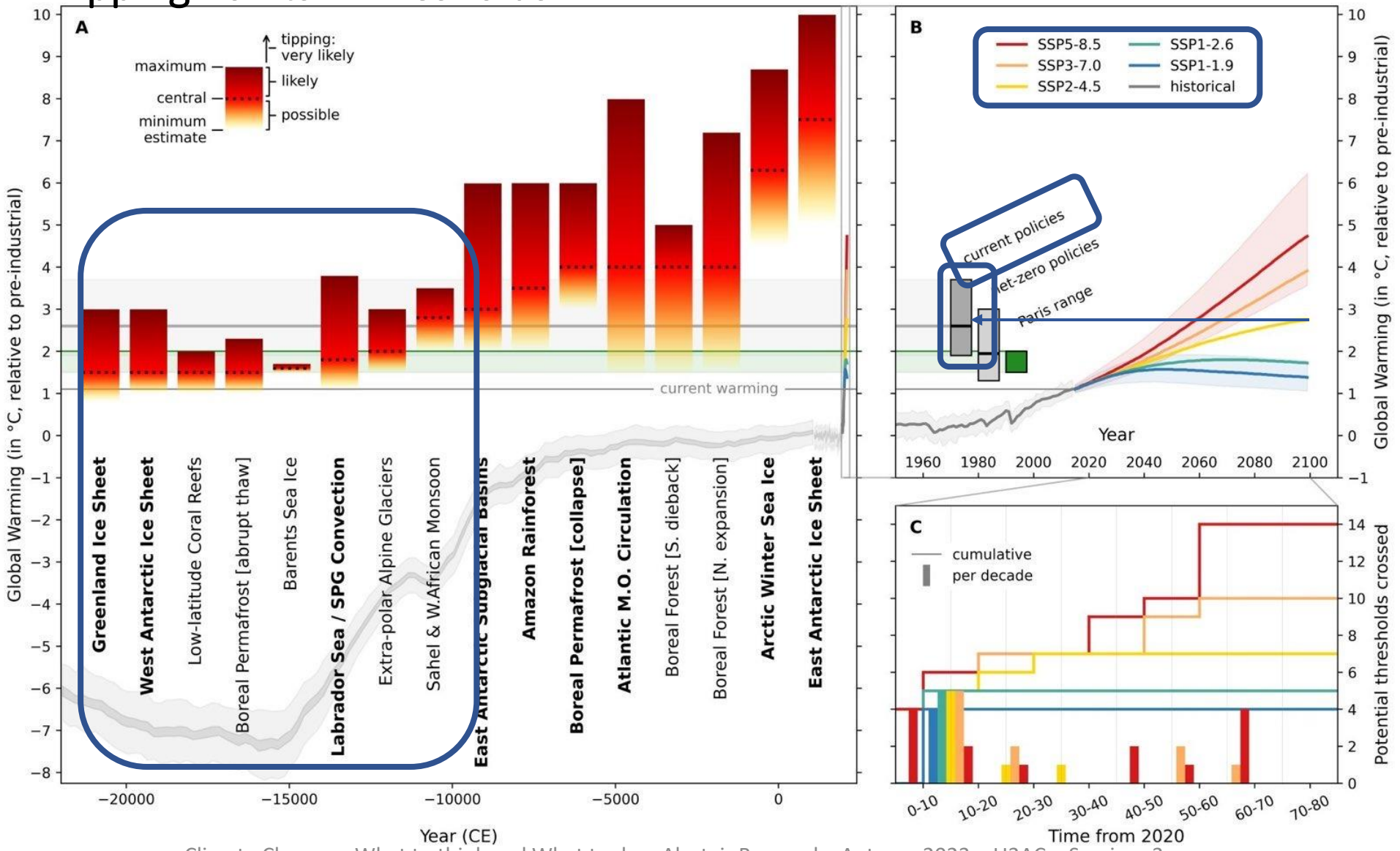


CarbonBrief
CLEAR ON CLIMATE

Evidence, Tipping Points, New Tech and Projections

Tipping Points - Thresholds

SSP: a shared socioeconomic pathway (global development scenario incl projections of population & economic growth, & technological and geopolitical trends). IPCC report uses 5. Good explainer: 5 possible climate futures—from the optimistic to the strange (nationalgeographic.com). Yellow is ~ 'current track'



Range of futures (top right)

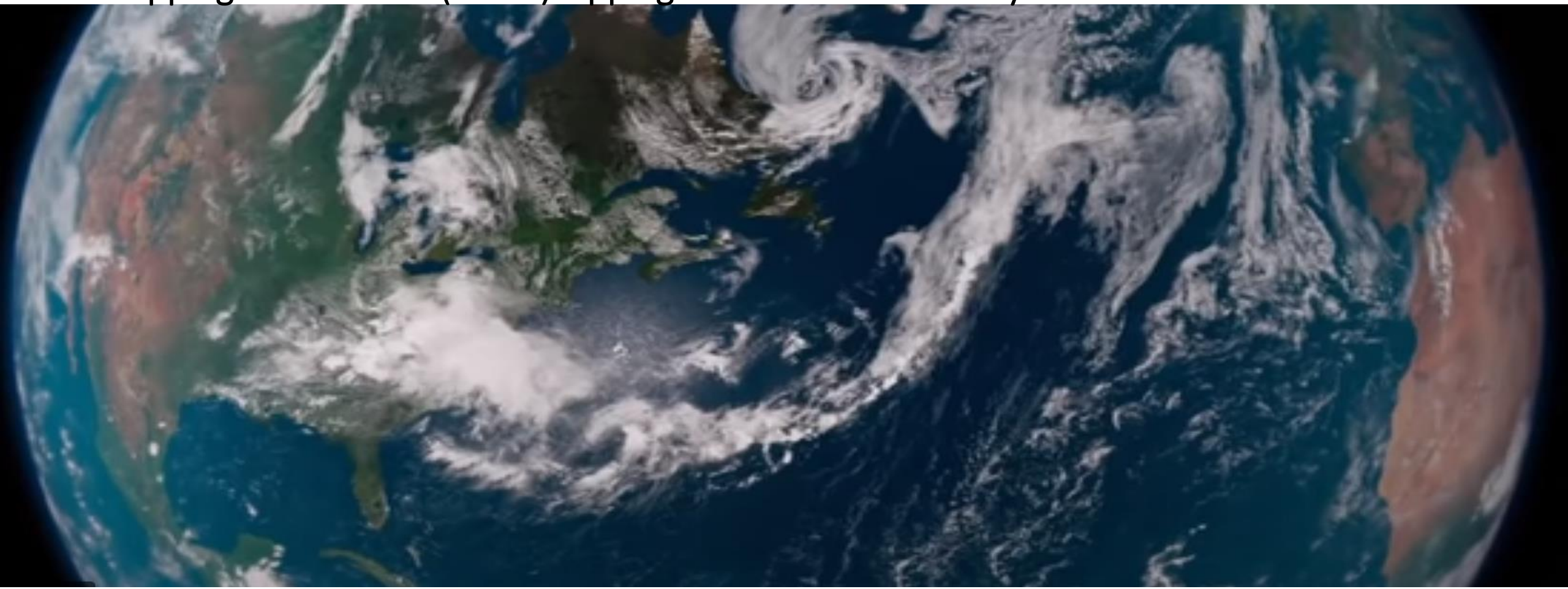
Track left to see likely tipping points triggered

Note the lowest horizontal line is not at zero.
1.1 degC today
2.5 degC likely now
3.75 on current policies

Note rubric top left re meaning of red bars

Bottom right shows timing of likely occurrences, under different warming scenarios

Tipping Points – The (META) Tipping Point that will Destroy the World



And on the Club of Rome report in 1972:

[MIT Has Predicted that Society Will Collapse in 2040 | Economics Explained - YouTube]

Tipping Points - Uncertainty is the Key Problem

- It's all very complex, and we just don't know
- But..
- "*Many scientists are looking for the* warning signs that herald *sudden changes in natural systems, in hopes of forestalling those changes, or improving our preparations for them. Our new study found, unfortunately, that regime shifts with potentially large consequences* can happen without warning *— systems can 'tip' precipitously. This means that some effects of global climate change on ecosystems can be seen only once the effects are dramatic. By that point returning the system to a desirable state will be difficult, if not impossible*."

  Prof Alan Hastings, Davis Department of Environmental Science and Policy at Univ Calif.
  (one of the world's top experts in using mathematical models to understand natural systems.)

- Which is why climate now is urgent (though the quotation is from 2010)
- We simply *cannot know* when nature might bite back, big time
  - As Clint Eastwood's Dirty Harry said.. "Do you feel lucky, punk?"

Interlude - Mental Stretch!

- Thus far, what I've presented has been pretty depressing.
- Hang in there!
- It gets better… you get to release your frustration more positively by doing something, rather than walking away.
- Take a pat on the back, and stick with it.

New Tech - Possibilities

Lots of ideas out there, e.g.:

BBC Radio 4 - 39 Ways to Save the Planet

The First Five Fascinating Ideas:

- super-strong building timber (reducing GHG-intensive steel and concrete)
- wind turbine repairing robots (cheapens their total cost of operation)
- secondary education for women in the developing world (fewer kids)
- planting seagrass (super-efficient carbon sink)
- rice without the paddy field (frees up water, cheaper to plant/harvest)
- and 34 more…

5 tech innovations that could save us from climate change | World Economic Forum (weforum.org) (2017)

- Fusion, batteries, lab-grown meat, CCS, smart software to avoid idling & traffic jams

Climate change: Seven technology solutions that could help solve crisis | Science & Tech News | Sky News (Oct 2021)

- CCS, feeding seaweed to cows, eating insects, climate-restoration, home-working, computing in data-centres, efficient home heating

New Tech - Possibilities

- Etc. etc. ad nauseam, and they mostly show promise and *will* help, BUT
- Could new technology solve climate change? - Grantham Research Institute on climate change and the environment (lse.ac.uk) (Sept 2022)
  - *"By the time new technologies are available in a form that works, at an affordable price, it could be too late" … "sensible climate mitigation action can and must happen now"*
- In general…
  - *Realistic* analysis concludes none of this will work *fast enough*
    - It takes time to ramp up deployment – we have enough good tech we're not using at scale
  - Unrealistic analysis just lists a load of feel-good waffle (very often, just Greenwashing)

New Tech - Categories

1. Emissions reducing
   - New (non-FF) sources of power
   - Reflective paint, ‘window film’ PV cells
   - Grown meat
2. Consequence reducing
   - Global Engineering (cloud seeding etc)
3. Emissions reversing
   - Carbon Capture & Storage

1 we’re doing (and must do much more)

2 is unsatisfactory and fraught with danger (acidification → famine, who decides?, allows continued raising of CO_2 → more greenwashing, can we put the genie back into bottle?)

3 may help reverse CO_2 concentrations one day, but is expensive, years away, no substitute for 1, and is largely a greenwashing smokescreen.

New Tech – Will Carbon Capture & Storage ("CCS") ride to the rescue?

- 2022 global capacity for removing CO_2 from the air was c 46M tonnes
- IEA projects this to grow to c 320M tonnes/yr by 2030
  - A *seven* fold increase in 7 years..
  - At which point it would still offset about 1% of global emissions
- Also (currently) expensive (c $400/tonne → c$150 by 2035 vs Euro ETS c$75)
- Very much hyped by those who emit CO_2
  - And on some conceptions, the point of capturing it is to *enable increased* emissions!
- So… possibly promising one day far in the future, and definitely worth working on
- But pretty much irrelevant when considering *what to do right now*

New Tech – Critical distinction

- "New Tech is irrelevant" is NOT the same thing as:
- "New Tech is irrelevant *when considering what we need to do right now*"
- The point is that "Tech will come along to save us" is a *very seductive, very effective* tool to reduce and discourage action
  - We indulge in this deception ourselves
  - *And* we have it done to us
- Therefore, while new tech is great, *almost every mention* should automatically raise a red flag in your head
- That huge caveat made, here's a great site:
  - Centre for Climate Repair at Cambridge
  - Initiative of Sir David King, eminent rational scientist *and* prophet of calamity ahead

Projections

- Now (post COP27)
  - Current pledges *for action* by 2030, if delivered in full, would mean a rise in global heating of about 2.5 degC and catastrophic extreme weather around the world.
    - A rise of 1 degC to date has already caused many climate disasters e.g. Pakistan floods.
  - If the long-term *pledges* by countries to *hit net zero emissions* by 2050 were all delivered, global temperature would rise by 1.8 degC.
    - But the glacial pace of action means this was "not credible" (UNEP).
  - *In-force* carbon-cutting policies would mean 2.8 degC of warming, while *pledged* policies cut this to 2.6 degC. Further pledges, dependent on funding flowing from richer to poorer countries, cut this again to 2.4 degC.
  - "*The [UNEP] report is a dire warning to all countries – none of whom are doing anywhere near enough to manage the climate emergency*." Prof David King, former UK chief scientific adviser
  - COP26 required countries to increase their pledges. But as COP27 loomed, only a couple of dozen had done so, and
    - Those new pledges would shave just 1% off emissions in 2030, while
    - Global emissions must fall by almost 50% by that date to keep the 1.5 degC target alive.
    - Additional pledges at COP27 were minimal (though finally it accepted the *principle* of aid/compensation)
- Future
  - Takeaway is – the future is very grim indeed.

Projections

Conclusions

The evidence is overwhelming
Govts and Institutions are just rearranging the deck chairs on the Titanic

- They're NOT going to save us, until *we ourselves* show that we'll destroy them if they don't act
- Action must start now, and it must be radical

The projections we've seen are not set in stone
Viewed holistically, human society is like a Super tanker

- Except it doesn't take 2 miles to stop
- It's already taken 50 years NOT to slow down at all
- But unlike a Super tanker, it's not the laws of physics here – it's our own rules

Tipping points are a wild card

- Maybe we are already utterly doomed and no-one alive knows that yet
- More likely, we'll find a way – but at what *added* cost (compared to current cost), due to yet further delay
- Let's not gamble

Tech won't save us, or even make much of a dent

- We need to turn off the tap *first*, and then find ways to pull out the plug (and mop the floor)

Every tenth of one degC matters - there is always something to play for
Anyone ignoring the problem, is part of the problem

PS

One concern coming through is ‘why should WE bother’?
The power of example – local, regional, national and international.
Why UK leadership is worth it. *ANYONE* leading is worth it. It won’t cost more.
Changing behaviour changes minds.